



Removing Hazardous Fuels from Forests to Reduce Greenhouse Gas Emissions from Uncharacteristically Severe Wildfires

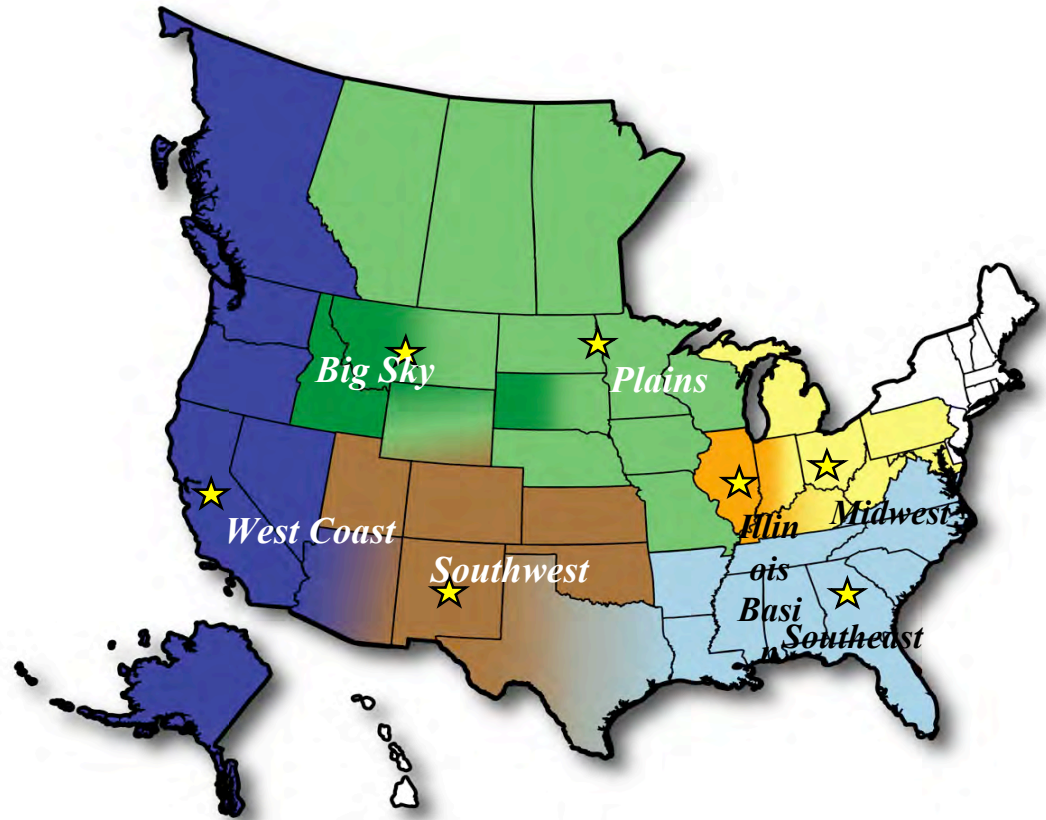
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Conference, Sacramento, California
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WESTCARB Is One of Seven DOE Regional Carbon Sequestration Partnerships

- Options for terrestrial and geologic CO₂ storage are evaluated
- Participation by 70 organizations provides broad stakeholder representation
- California Energy Commission is prime contractor



Summary

- Results of research to estimate carbon benefits from reducing GHG emissions associated with fire
- Does it make economic sense to remove the accumulation of hazardous fuels from forests?
- Forest fuels as feedstocks for biofuels and power



Not all forests
are the same

Photos: Dr. Sam Sandberg, USDA Forest Service

Not all forest fires
are the same

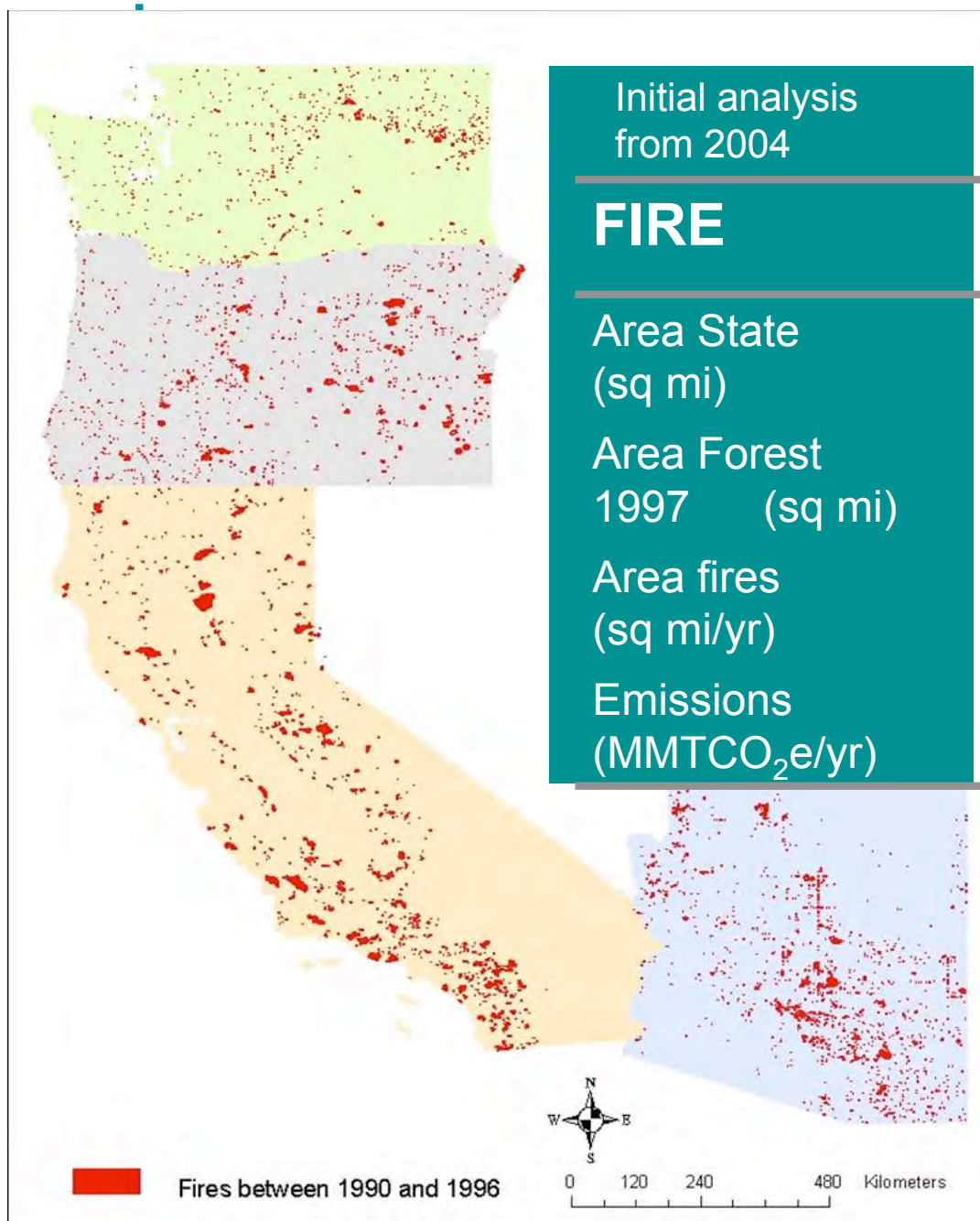


Potential Sequestration Benefits from Improved Fuel Management



Source: Sandberg, USDA Forest Service

- Bring fire to the ground
- Reduce fire severity
- Reduce GHG emissions from loss of carbon stocks
- Increase growth rates in residual stand



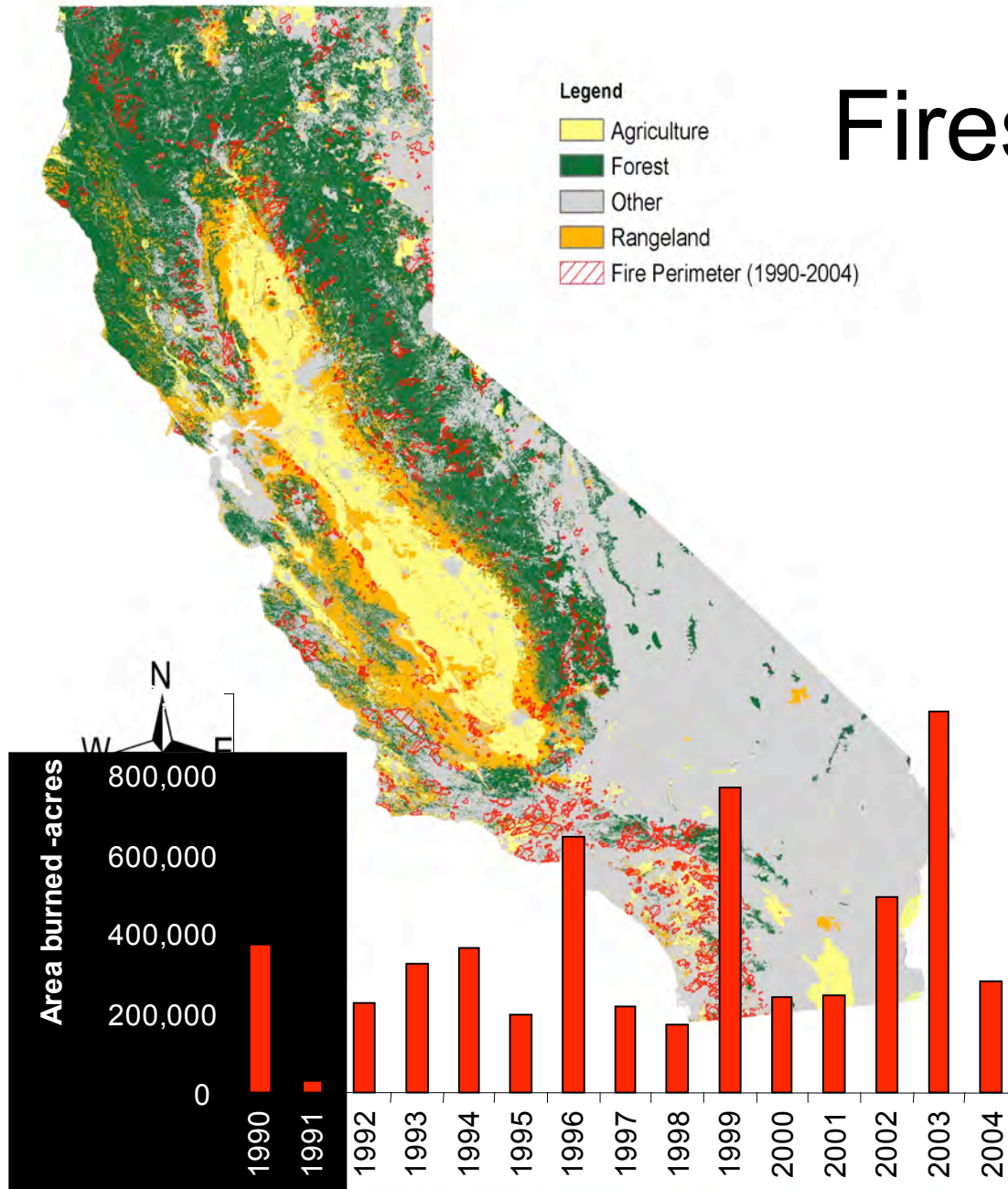
(1990 – 1996)

FIRE	CA	OR	WA	AZ
Area State (sq mi)	163,707	98,386	71,303	114,006
Area Forest 1997 (sq mi)	60,228	46,438	34,208	31,134
Area fires (sq mi/yr)	484	21*	4.6*	24
Emissions (MMTCO ₂ e/yr)	1.46**	1.03	0.18	0.47

* Fire data is missing for 1994 in Oregon and Washington due to satellite failure.

** Analysis from LCMMP dataset in California, 3 regions represent 84 % of total forests in State, 42 % of rangelands.

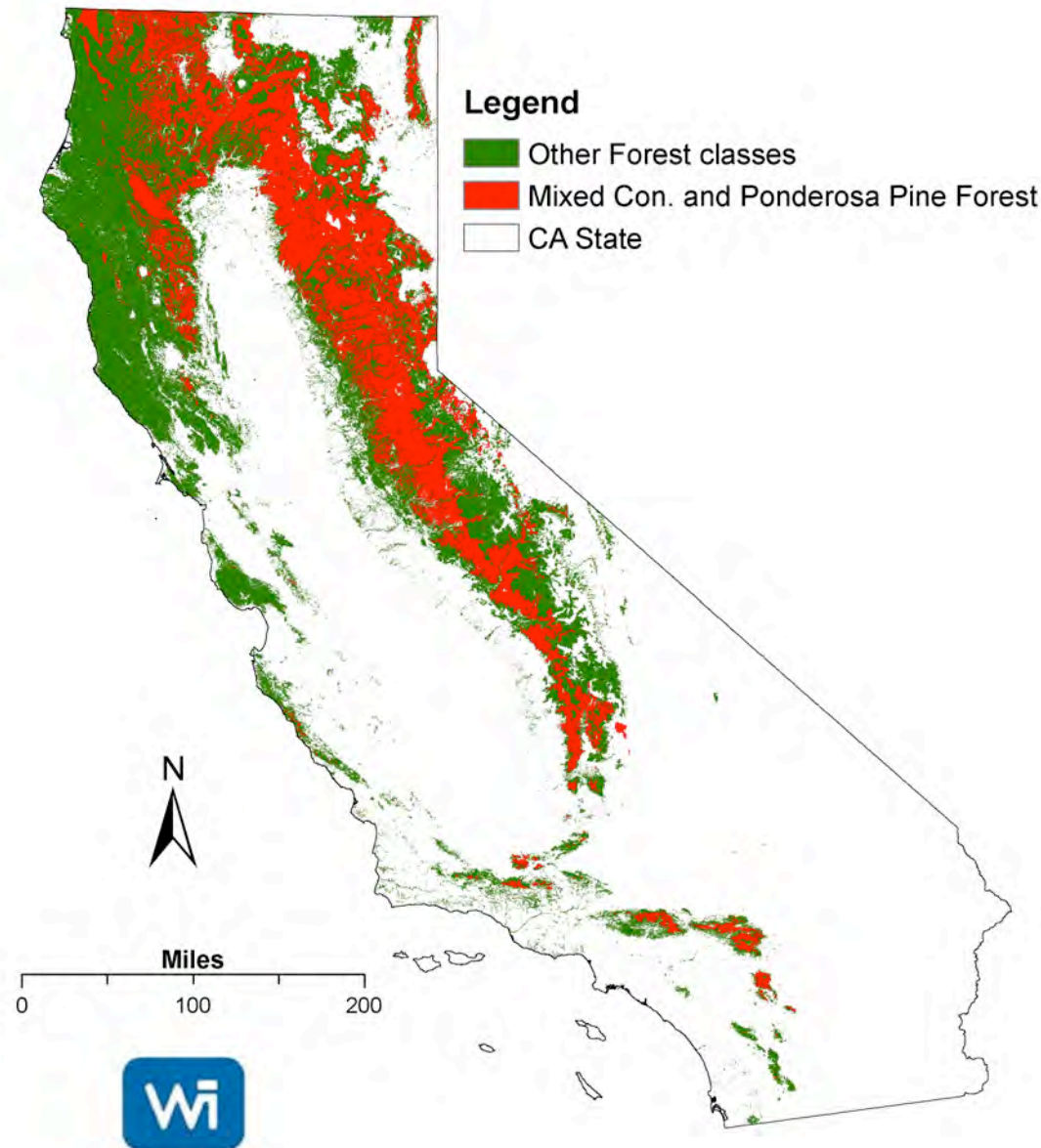
Fires in California



Total area burned
in 1990-2004
= 5.5 million acres

So far in 2006,
334,000 acres

Emissions from
fires during period
~ 26 MMT CO₂
plus other GHGs



CA forests at high/
very high risk of fire
that could benefit
from treatment =
16.2 million acres

About 2.2 million
acres meet
constraints for
treatment used in
analysis

Constraints: Slope,
yarding distance, block
size and distance to
biomass plant

Example from Cone Fire -- 2002

- Treatments affect changes in carbon stocks attributable to fire



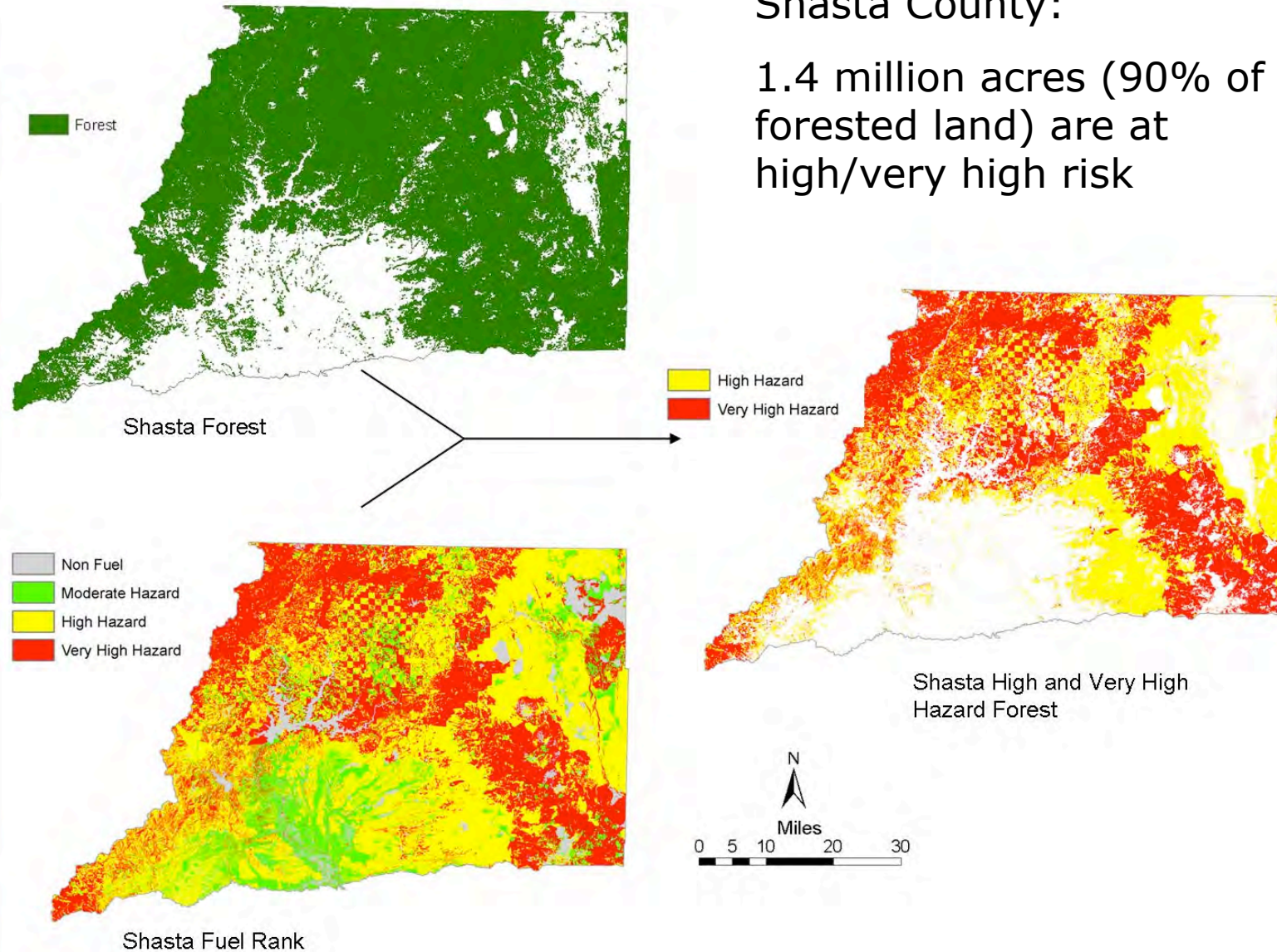
Area treated with thinning and prescribed burn prior to fire.

Area untreated prior to fire.

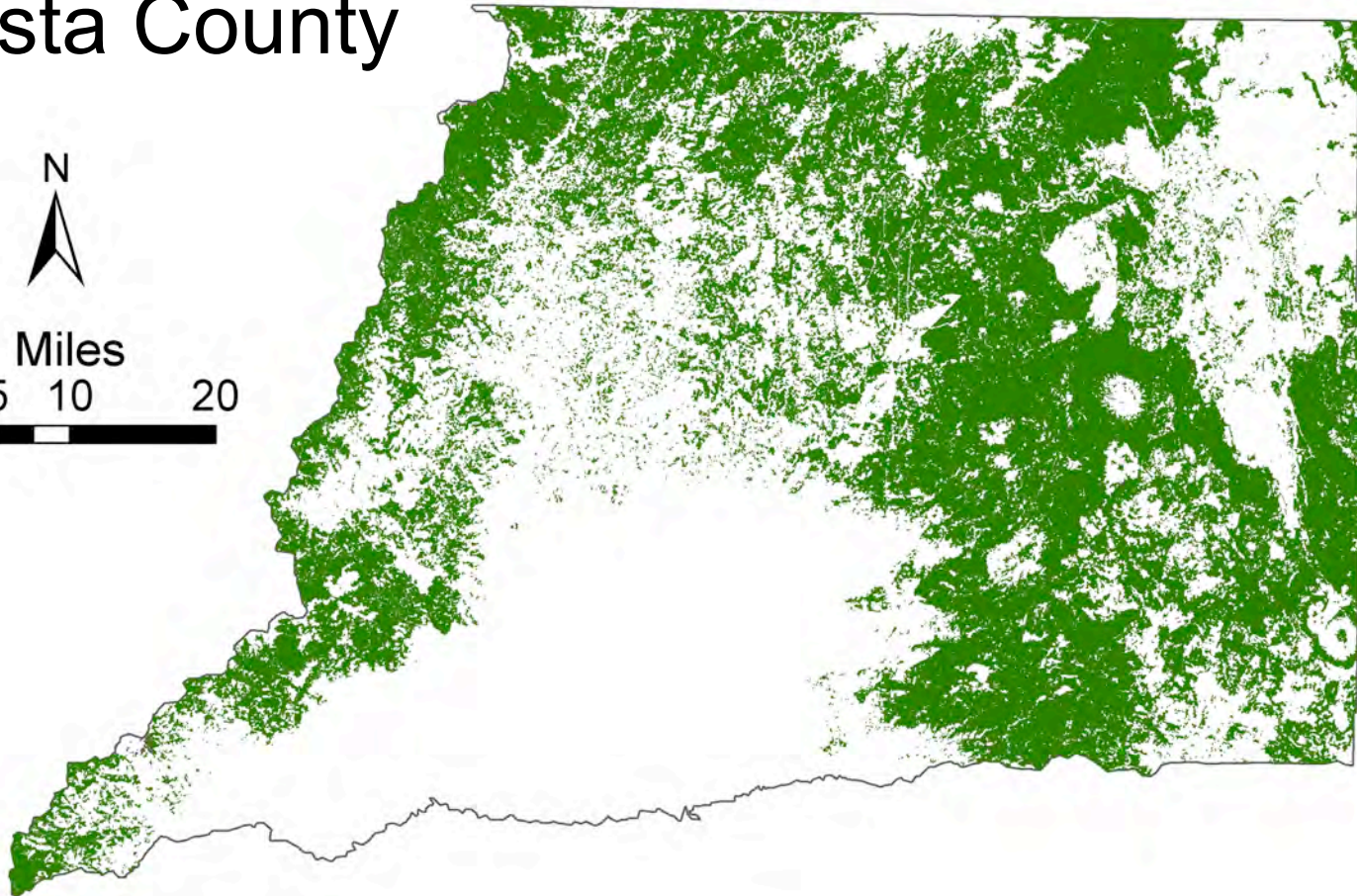
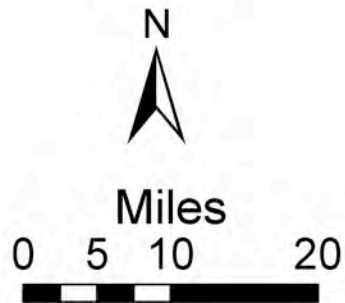
Source: "Cone Fire Tests Fuel Reduction Treatment Effectiveness," Gary Nakamura, UC Cooperative Extension, 2002. Photos: USFS PWS Research Station, Redding, CA.


Shasta County:

1.4 million acres (90% of forested land) are at high/very high risk

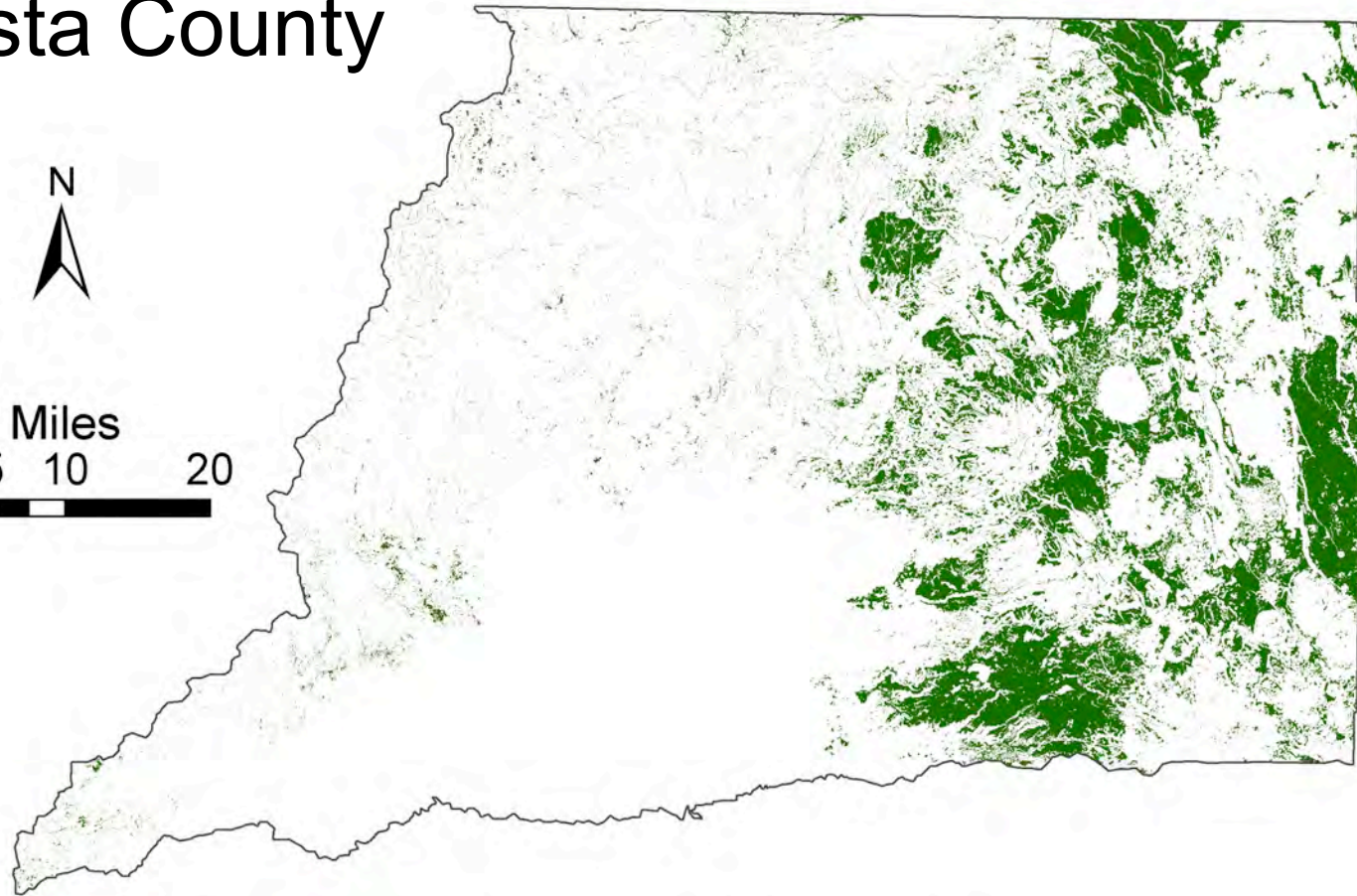
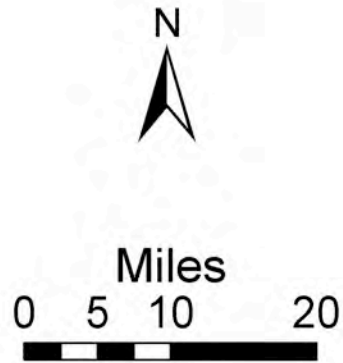


Shasta County



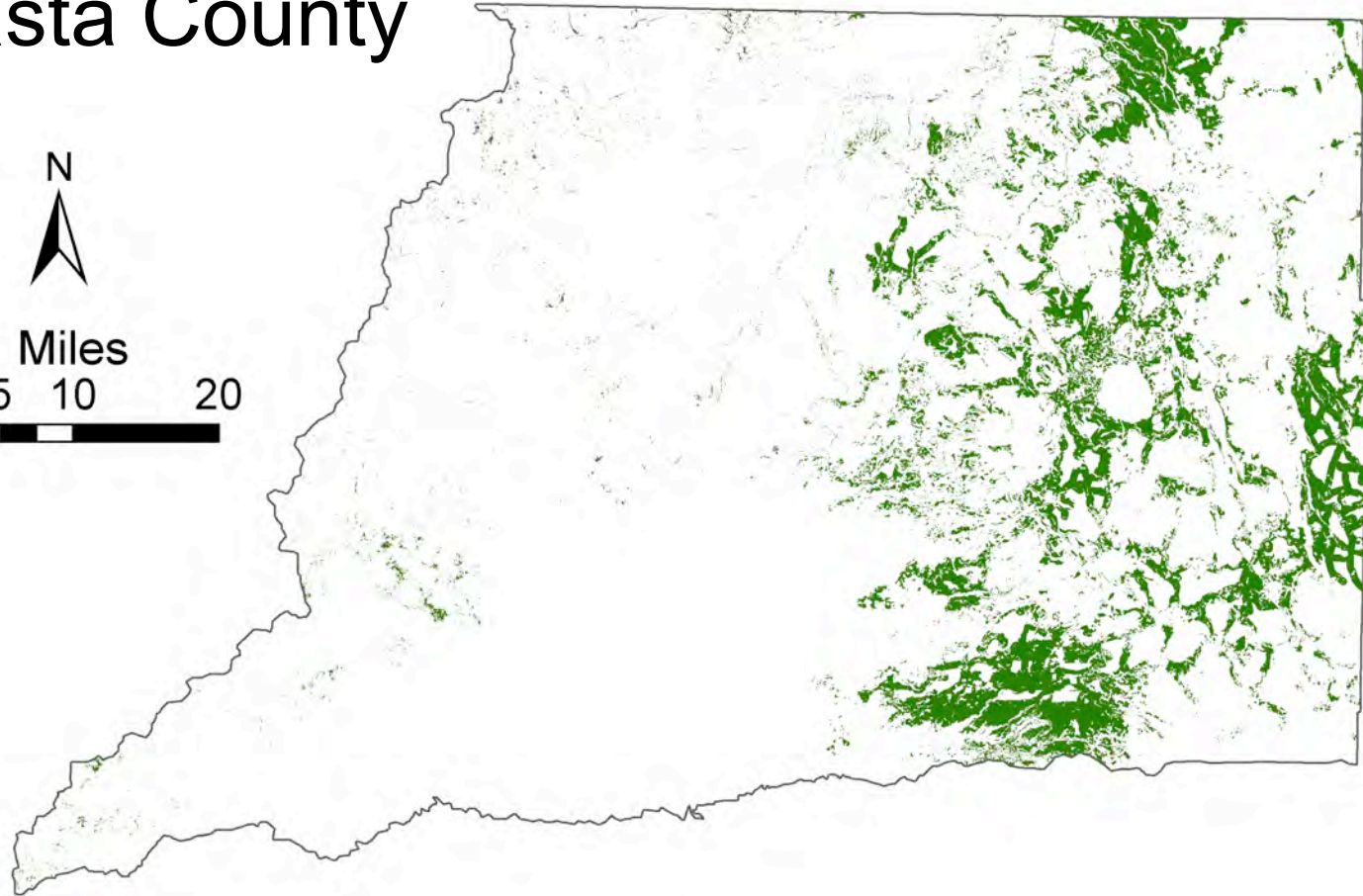
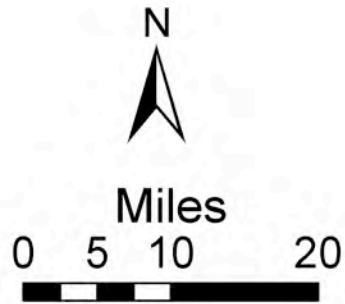
 Mixed Conifer Forest


Shasta County



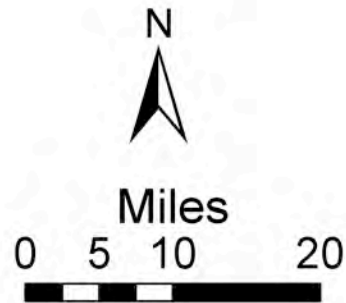
 Mixed Conifer Forest on slope $\leq 40\%$

Shasta County



 Mixed Conifer Forest on slope $\leq 40\%$ and within 0.25 mi from roads




Shasta County

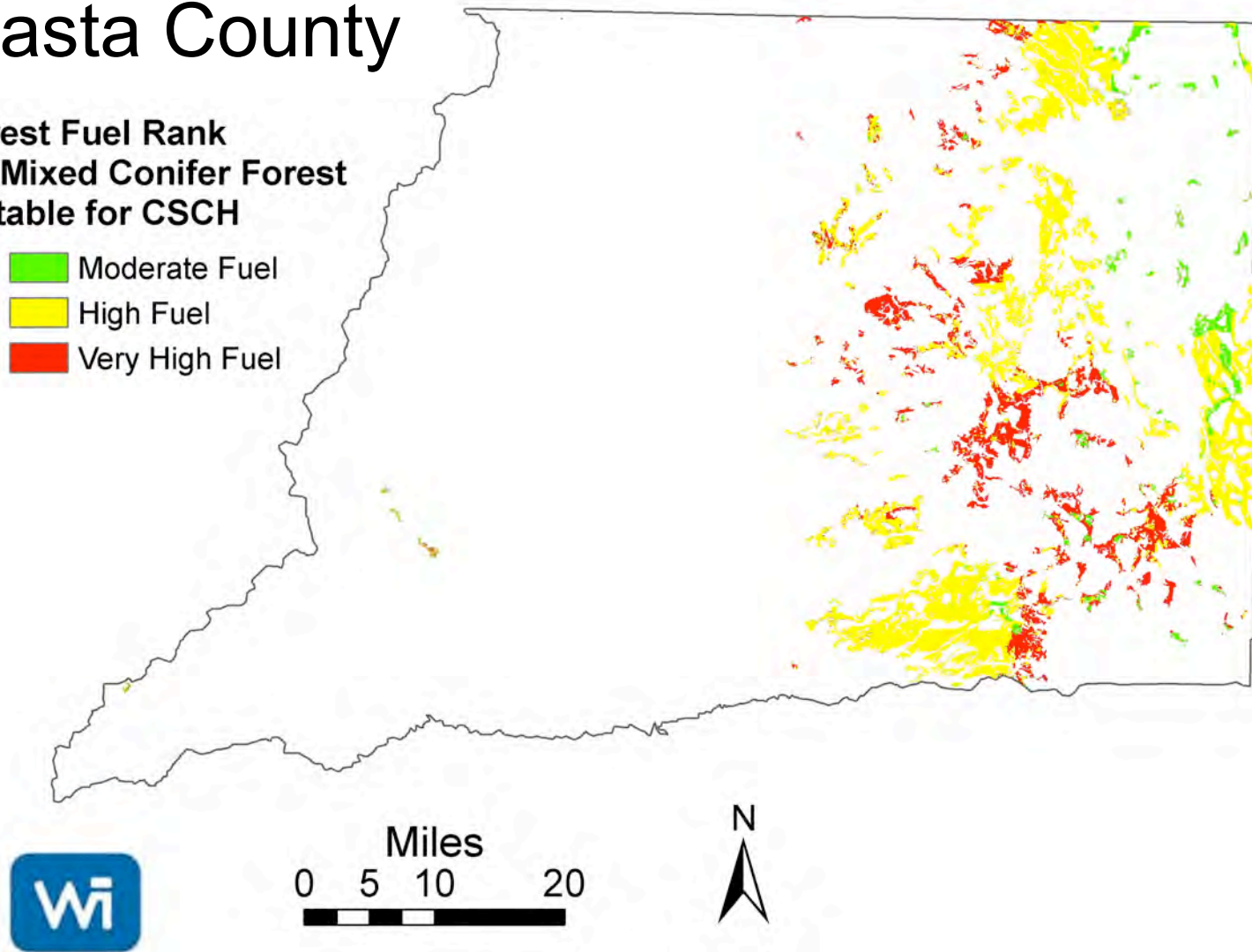


Mixed Conifer Forest - slope $\leq 40\%$, 0.25 mi from roads and block size > 80 ac

Shasta County

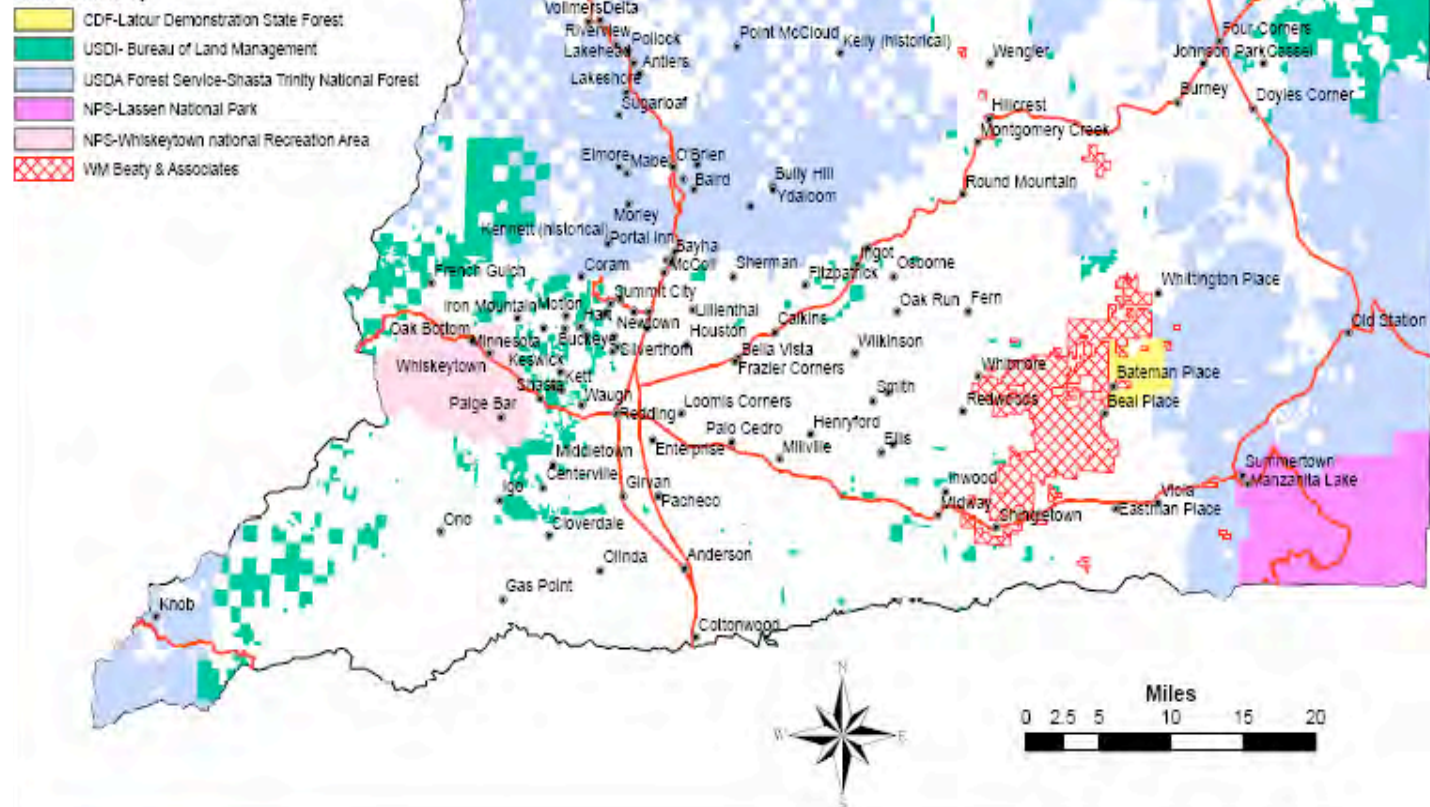
**Forest Fuel Rank
for Mixed Conifer Forest
suitable for CSCH**

-  Moderate Fuel
-  High Fuel
-  Very High Fuel



Shasta County

Land Ownership



Results for Shasta County

Shasta County	
Forest land at high or very high risk of fire (acres)	1,410,000
High or very high fire risk land that satisfies constraints (acres)	215,000
Potential removable fuel based on field data (tons C/acre)	9.3
Total removable fuel from treatable land (BDT biomass)	4 million
Potential emissions credits (\$/acre)	@\$10/tCO ₂ , \$350-700/acre

Treatment Costs

Treatment	Product yield	Representative Costs
Prescribed fire	No	\$35-300/acre, average \$92/acre ¹
Masticate and leave on site	No	\$100-1000/acre ²
Cut-pile-burn	No	\$100-750/acre ²
Cut-skid-chip-haul	Yes	\$560 – 1634/acre ³ or \$34-48/BDT + haul cost ³

1 USDA Forest Service R&D/Western Forestry Leadership Coalition, 2003.

2 Chalmers and Hartsough, no date

3 Fried et al. 2003

More detailed information on the data and analysis for California covered in this presentation can be found in:

- **“Carbon Supply Curves for Forest, Range, and Agricultural Lands of California: Final Report,” March 2004.**
- **“Carbon Supply from Changes in Management of Forest, Range and Agricultural Lands of California: Forest Fuel Reduction,” Update October 2005,**
- **“Baseline Greenhouse Gas Emissions and Removals for Forest and Rangelands in Shasta County, California,” August 2006.**
- **“Carbon Supply from Changes in Management of Forest and Rangelands in Shasta County, California,” *in review.***
- **Available online now or soon at**
http://www.energy.ca.gov/pier/final_project_reports/

Reports prepared by Winrock International with support from the Electric Power Research Institute and California Energy Commission

Ongoing Research

- WESTCARB Terrestrial Pilot Projects in CA and OR
 - Develop fire methodology including baselines and monitoring protocols
 - Collect data on: (1) Emissions from wildfires of varying severity, (2) Treatment costs, (3) Carbon stocks pre- and post-treatment, and (4) Regrowth following fires of different severity
- US Forest Service joint venture research agreement in CA
 - Classify national forest lands for treatment
 - Quantify net carbon benefits of fuels reduction and bioenergy on national forest lands

Methodology for Determining Emission Reductions from Reducing Fuel Loads

Hazardous Fuel Load	Age Class			
	<10 yrs	10-40 yrs	40-80 yrs	>80 yrs
Low				
Medium				
High				

Assign emissions factors based on multi-criteria analysis. The objective of fuel treatments is to move from High to Medium to Low hazardous fuel factor.

Methodology Panel meets in Redding October 24-25.

Does hazardous fuel removal make economic sense?

- Quantifiable sources of revenue
 - Emissions credits for avoided GHG emissions
 - State and federal fire suppression costs
 - Bioenergy
- Prospective sources of revenue
 - Reduced emissions of other pollutants
 - Reduced insurance losses





Fire Benefits

- Ten-year average (1996-2006) of 4.8 million acres per year
- Suppression costs to federal agencies for 1994-2004 period averaged \$830 million per year (\$1.2 billion per year for 2000-04)
- Average value per acre \$250/acre

Source: National Interagency Fire Center

U. S. Biomass Energy Experience

- Electricity from wood residues:

312 plants with 6,585 MWe capacity

- Heat from wood residues:

80% of wood energy use by forest product companies is heat or steam in 3000+ plants

- Cost to produce power

- \$0.05/kWh with free fuel on site
- \$0.09/kWh with fuel at \$40/ton

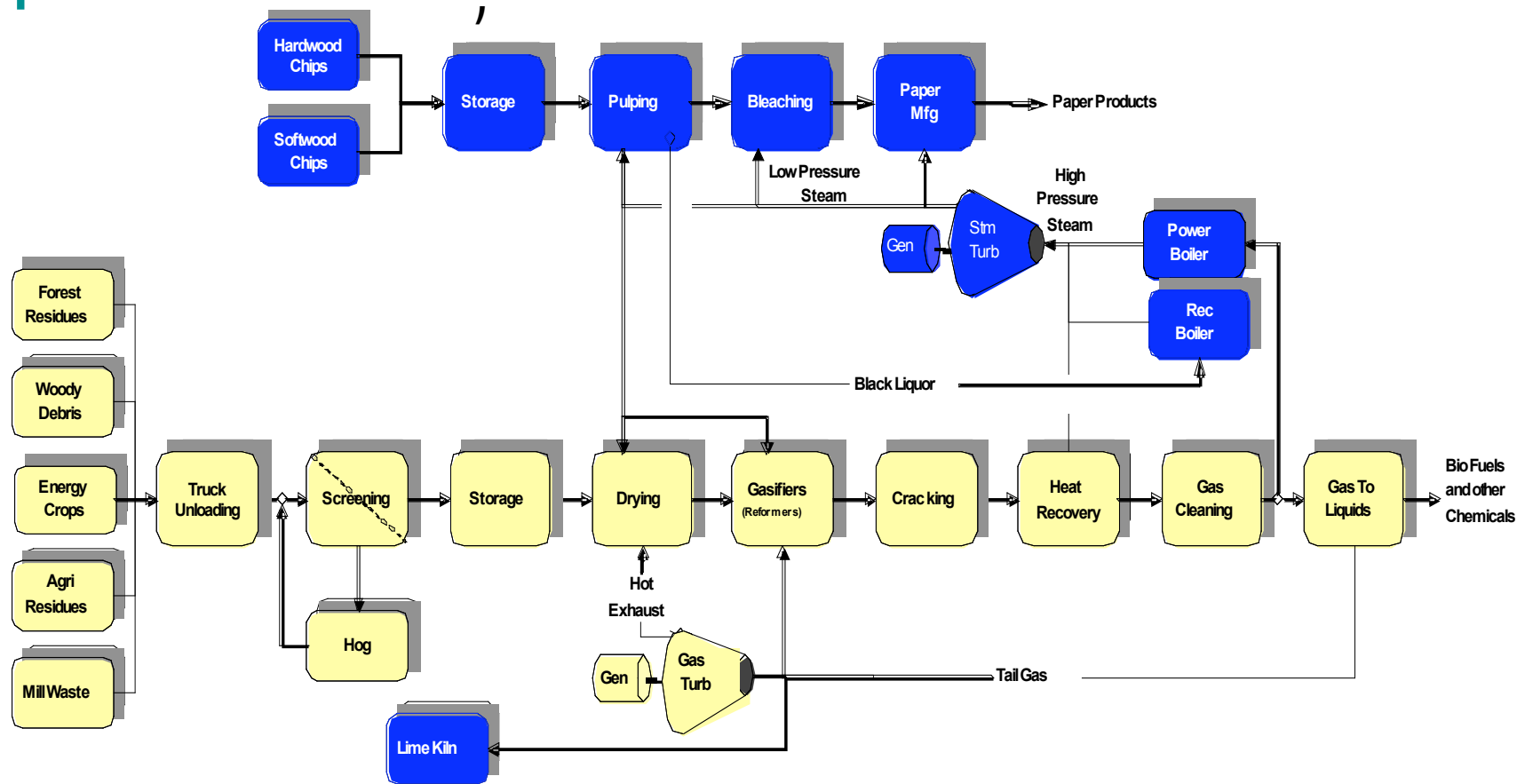
Feedstocks

- Bioenergy Plan for California
 - 30 million dry tons available
 - 4 MDT used today at 28 power plants
 - Ag 29% -- > 50% animal manure
 - Forest 45% -- > 50% slash & thinnings
 - MSW 26%

Heat vs Power vs Liquid Fuels

- Heat for thermal applications
 - Each \$10 per ton fuel adds \$0.63/million BTUs
- Power generation
 - Each \$10 per ton fuel cost adds \$0.01/kWh
- Liquid fuels
 - Each \$10 per ton fuel cost adds \$0.10/gallon

Potlatch Biorefinery



Projected yield of 50-55 gallons per BDT.

California Air Emissions from Burning Biomass

10 year annual average (tons/day)	Reactive Organic Gases	CO	NOx	SOx	PM10
Agriculture	19.3	216	5.6	0.2	25.6
Range	23.5	309	3.7		45.3
Forest	28.4	720	6		52.1
Wildfire	128.4	2,482	79.4	24.5	253.4
Wood-Fired Boilers	0.37	50	5.1	0.5	1.1

Source – California Air Resources Board Emissions Inventory 2004

Linking Terrestrial with Geologic Sequestration

